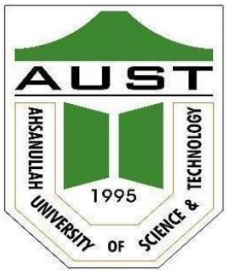

Ahsanullah University of Science & Technology

Department of Computer Science & Engineering

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Course Title : Digital System Design Lab
Assignment No : 01

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Introduction:

The main purpose of this experiment is to design a 4bit Arithmetic and Logical unit. from the given function table. An arithmetic logic unit (ALU) is a digital circuit used to perform arithmetic and logic operations. In this experiment, from the given function we will generate function. For this, we will have to derive equation from the given table using the selector bits for three inputs. After simplifying the equation, we will need to implement these functions in the Proteus. Thus ALU will generate the output of the given functions.

Problem Statement:

S_2	S_1	S_0	Output	Function
0	0	0	$A_i - B_i - 1$	Subtract with borrow
0	0	1	A_i	Transfer A
0	1	0	$A_i - 1$	Decrement A
0	1	1	$A_i + B_i - 1$	Add with Carry
1	0	X	A_i'	Complement A
1	1	X	$A_i . B_i$	AND

Function Generation:

S_2	S_1	S_0	Z	X	Y	Output	Function
0	0	0	0	A_i	$\overline{B_i}$	$A_i - B_i - 1$	Subtract with Borrow
0	0	1	0	A_i	0	A_i	Transfer A
0	1	0	0	A_i	1	$A_i - 1$	Decrement A
0	1	1	1	A_i	B_i	$A_i + B_i + 1$	Add with Carry
1	0	x	0	$\overline{A_i}$	0	$\overline{A_i}$	Complement A
1	1	x	0	$A_i . B_i$	0	$A_i . B_i$	AND

K-Map:

For Z,

S_2 \ S_1S_0	$\overline{S_1}\overline{S_0}$	$\overline{S_1}S_0$	S_1S_0	$S_1\overline{S_0}$
$\overline{S_2}$	0	0	[1]	0
S_1	0	0	0	0

$$Z = \overline{S_2} S_1 S_0$$

For Y,

S_2 \ S_1S_0	$\overline{S_1}\overline{S_0}$	$\overline{S_1}S_0$	S_1S_0	$S_1\overline{S_0}$
$\overline{S_2}$	[$\overline{B_i}$]	0	[B_i]	[1]
S_2	0	0	0	0

$$= \overline{S_2}\overline{S_1}\overline{S_0}\overline{B_i} + \overline{S_2}S_1S_0B_i + \overline{S_2}S_1\overline{S_0}.1$$
$$= \overline{S_2}\overline{S_1}\overline{S_0}\overline{B_i} + \overline{S_2}S_1(S_0B_i + \overline{S_0})$$
$$= \overline{S_2}\overline{S_1}\overline{S_0}\overline{B_i} + \overline{S_2}S_1(\overline{S_0} + B_i)$$
$$= \overline{S_2}\overline{S_1}\overline{S_0}B + \overline{S_2}S_1\overline{S_0} + \overline{S_2}S_1\overline{S_0}B_i$$
~~$= \overline{S_2}A_i + S_2(\overline{S_1}\overline{A_i} + S_1A_iB_i)$~~

$$= \overline{S_2}\left(\overline{S_1}\,\overline{S_0}\,\overline{B_i} + S_1\overline{S_0} + S_1\overline{S_0}\,B_i\right)$$

$$= \overline{S_2}\left(\overline{S_1}\,\overline{S_0}\,\overline{B_i} + S_1\overline{S_0}\,(1 + B_i)\right)$$

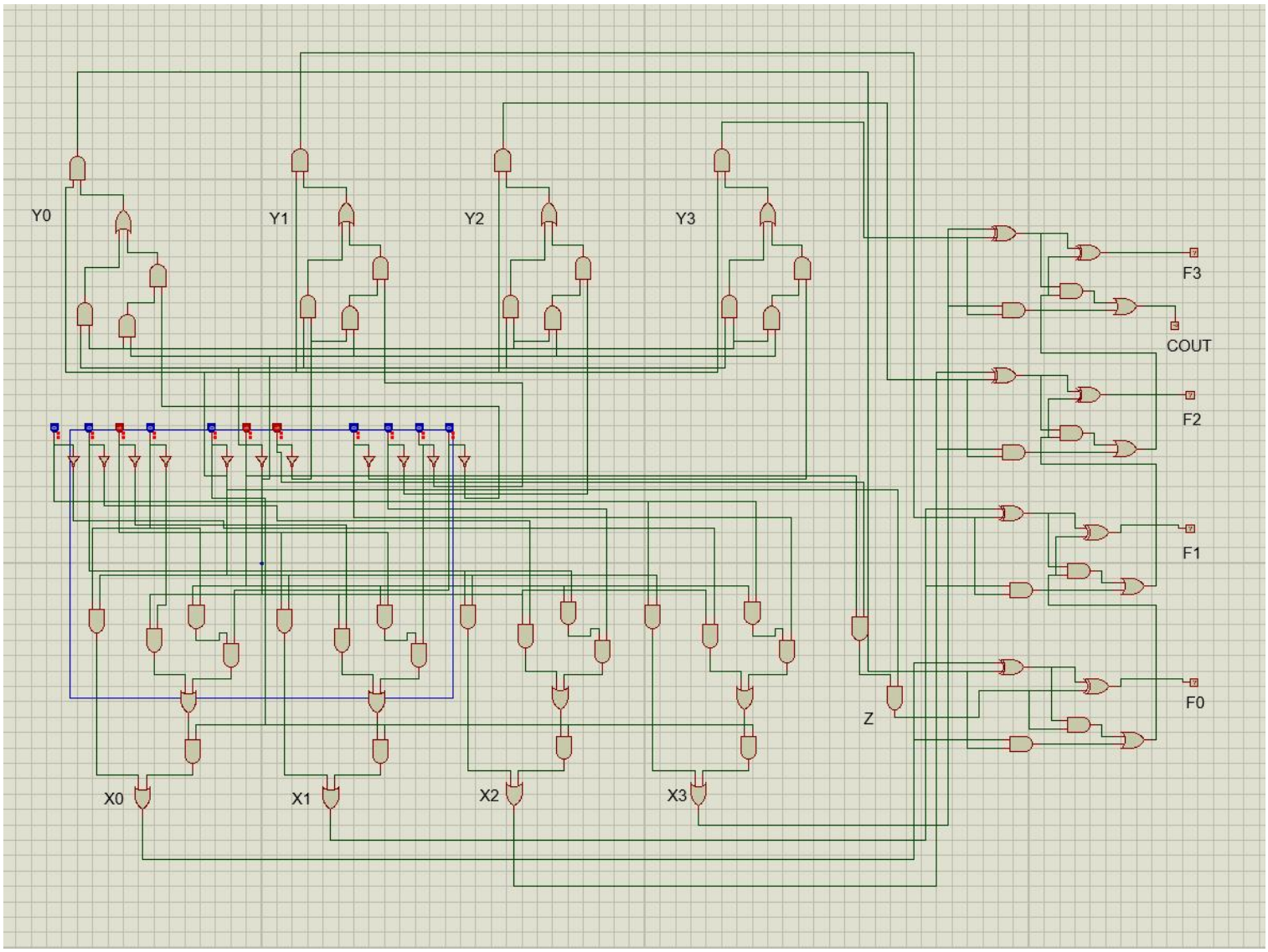
$$= \overline{S_2}\left(\overline{S_1}\,\overline{S_0}\,\overline{B_i} + S_1\overline{S_0}\right)$$

For X,

S_2 \ S_1S_0	$\overline{S_1}\,\overline{S_0}$	$\overline{S_1}\,S_0$	S_1S_0	$S_1\overline{S_0}$
S_2	A_i	A_i	A_i	A_i
$\overline{S_2}$	$\overline{A_i}$	X	X	A_iB_i

$$X = \overline{S_2}A_i + S_2\overline{S_1}\,\overline{A_i} + S_2S_1A_iB_i$$

$$= \overline{S_2}A_i + S_2\left(\overline{S_1}\,\overline{A_i} + S_1A_iB_i\right)$$


Y0
Y1
Y2
Y3
F3
COUT
F2
F1
F0
Z
X0
X1
X2
X3

Equipment and Budget:

IC Number	Grate	Piece (IC)	Price (Each)	Price (Total)
IC 7404	NOT	2	25	50
IC 7408	2 Input AND	12	20	240
IC 7432	2 Input OR	4	25	100
IC 7486	2 Input XOR	2	23	46
Breadboard		1	165	165

Total Cost = 601.

Result:

For substracting with borrow operation >>

	Input										Output				
S_2	S_1	S_0	A_3	A_2	A_1	A_0	B_3	B_2	B_1	B_0	Cout	F_3	F_2	F_1	F_0
			0	1	0	1	0	0	1	0	1	0	0	1	0
0	0	0	1	0	0	1	0	1	0	0	1	0	1	0	0
			1	1	0	0	1	0	0	0	1	0	0	1	1

For transfer A operation:

	Input										Output				
S_2	S_1	S_0	A_3	A_2	A_1	A_0	B_3	B_2	B_1	B_0	Cout	F_3	F_2	F_1	F_0
			0	1	0	1	0	0	0	0	0	0	1	0	1
0	0	1	1	0	0	1	0	0	0	0	0	1	0	0	1
			1	1	0	0	0	0	0	0	0	1	1	0	0

For decrement operation:

	Input										Output				
S_2	S_1	S_0	A_3	A_2	A_1	A_0	B_3	B_2	B_1	B_0	Cout	F_3	F_2	F_1	F_0
			0	1	0	1	0	0	1	0	1	0	1	0	0
0	1	0	1	0	0	1	0	1	0	0	1	1	0	0	0
			1	1	0	0	1	0	0	0	1	1	0	1	1

Add with carry operation:

	Input										Output				
S_2	S_1	S_0	A_3	A_2	A_1	A_0	B_3	B_2	B_1	B_0	Cout	F_3	F_2	F_1	F_0
			0	1	0	1	0	0	1	0	0	1	0	0	0
0	1	1	1	0	0	1	0	1	0	0	0	1	1	1	0
			1	1	0	0	1	0	0	0	1	0	1	0	1

For NOT Operation:

	Input										Output				
S_2	S_1	S_0	A_3	A_2	A_1	A_0	B_3	B_2	B_1	B_0	Cout	F_3	F_2	F_1	F_0
			0	1	0	1					0	1	0	1	0
1	0	X	1	0	0	1	0	0	0	0	0	0	1	1	0
			1	1	0	0					0	0	0	1	1

For AND Operation:

	Input										Output				
S_2	S_1	S_0	A_3	A_2	A_1	A_0	B_3	B_2	B_1	B_0	Cout	F_3	F_2	F_1	F_0
			0	1	0	1	0	0	1	0	0	0	0	0	0
1	1	X	1	0	0	1	0	1	0	0	0	0	0	0	0
			1	1	0	0	1	0	0	0	0	1	0	0	0

Conclusion:

The software we use to execute the simulation have some realistic feature, on that account the instrumental errors occured. Concerning our first step, we derived the equation of the inputs, simplified those input equations and reduced the equation. Our ALU was displaying inaccurate results on ~~input~~ outputs for logical operations however was working correctly for arithmatic operation. Thus we have implemented the circuit using the direct equations we aquired from the table without simplifying it and this time the function were working correctly, But when we are going to implement this practically, there might be an issue in view of the fact that we have used many IC's and circuit becomes more prone to error.